Experiment # 2: Part-A

Measure velocity profile, both mean and fluctuating component, in the turbulent wake behind a circular cylinder using hot-wire anemometer.

Learning Objectives:

a) Use of hot-wire anemometry for velocity measurement

b) Analysis of hot-wire data to obtain mean and fluctuating part of the velocities

c) Wake characteristics behind a circular cylinder

Proposed Plan:

a) Study the experimental set-up including each and every component with specification.

b) Study the circuit diagram for a constant temperature hot wire circuit.

c) Mount the hot-wire probe in the traversing mechanism and make the necessary signal connection.

d) Make a block diagram of the experimental set up.

e) Calibrate hot wire probe in the free stream without any model in the tunnel.

f) Use a rough cylinder model to generate turbulent wake

g) At one free stream wind speed at a stream-wise station, x, measure velocity profiles, both mean and fluctuating component, in the turbulent wake. The origin of x coordinate is at the center of the cylinder and it is increasing in the stream-wise direction.

h) Plot velocity profiles, both mean and rms, in normalized forms.

Questions:

1) How does constant temperature hot-wire anemometer work?

2) How do you calculate mean and rms velocity components from hot wire signal?

3) What is the nature of the hot-wire signal in the free stream?

4) What do you understand by the intermittency in a turbulent wake?

Experiment # 2: Part-B

Study the dependence of shedding frequency in the Karman vortex street of the circular cylinder wake on Reynolds number.

Learning Objectives:

To understand the principles of a Constant temperature anemometer and thereby to study the vortex shedding frequency of a cylinder wake and to observe the variation of Strohaul number with Reynolds number.

Proposed Plan:

a) You are provided with four circular cylinders of different diameters. Measure the diameters with the help of a digital Vernier.

b) Mount the hot wire in the near wake (about 3 diameters) of the circular cylinder. Turn the wind tunnel on. At an appropriate wind speed the hot wire signal will show a sine wave. Note the frequency of the sine wave. This corresponds to the frequency of the vortex shedding.

c) Increase the Reynolds number and note the variation in the shedding frequency.

d) Calculate Strouhal number, $S = fd/v$, and Reynolds number. Plot results as $S = f(\mathrm{Re})$.

Questions:

1) What do you observe when the hot wire probe is moved across the cylinder wake? Explain the reason.

2) Can you use this method to measure low wind speed? Explain.

3) Sketch the flow field on a circular cylinder as a function of Reynolds number. Start with the inviscid flow. Comment on drag and other characteristics.

4) What happens to the shedding frequency when the hot wire probe is moved across the cylinder near wake? Explain.

References:

1. Schlichting, ``Boundary layer theory," McGraw Hill, New York, 1970.
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3. Turbulence - Hinze
4. A first course in turbulence - Tennekes & Lumley
5. L. Ong and J. Wallace, “The velocity field of the turbulent very near wake of a cylinder,” Experiments in Fluids, 20 (1966).